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AUTHOR Anderson, Cheryl A.
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ABSTRACT

Focusing on use of the computer as an object of instruction, this paper provides a rationale for teaching computer literacy and explores a variety of definitions for the term. Also discussed are various curriculum approaches that are being developed to teach computer literacy content, which include teaching the content in a separate course and the infusion of computer literacy skills within an existing curriculum. Examples of computer literacy curricula are provided for the elementary, secondary, and college levels. Finally, the paper addresses the problems that are resulting from this new curriculum development, specifically, teacher training and equality of access to computer skills. Nineteen references are listed. (Author/LMM)

Computer Literacy: Rationale, Definition and Practices

by
Dr. Cheryl A. Anderson
University of Texas at Austin

Presented at a Satellite Teleconference
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Abstract

Computer Literacy:

Rationale, Definition, and Practices.

by Cheryl A. Anderson

University of Texas at Austin

Microcomputers are responsible for the increased interest that educators have for using computers as a method for delivering instruction and as an object of instruction. This paper, presented at a satellite teleconference on Microcomputers in Education, focuses on using the computer as an object of instruction or as it is more commonly termed - "Computer Literacy". The paper provides a rationale for teaching computer literacy and explores a variety of definitions. Also discussed are various curriculum approaches that are being developed to teach computer literacy content. These approaches include teaching the content in a separate course and the infusion of computer literacy skills within an existing curriculum. Examples of computer literacy curriculums are provided for the elementary, secondary and college levels. Finally, the paper addresses the problems that are resulting from this new effort curriculum development, specifically, teacher training and equality of access to computer skills.

Computer Literacy: Rationale, Definition and Practices

In a recent Fast Response Survey (1982) conducted for the U.S. Department of Education it was determined that American students have access to 96,000 microcomputers and 24,000 computer terminals. This figure is up from a 1980 survey which found there were 31,000 microcomputers and 22,000 computer terminals in public schools across the nation. The 1981-82 study found that 29,000 public schools in this nation have at least one computer for instructional use. The Department of Education indicates that the computers are being used by 4.7 million students for an average of 9 hours per year. Not suprisingly they also found that the availability of computers varied according to grade level with the heaviest concentration of computers at the secondary level. The major educational application, however, was the same at both the elementary and secondary level - that application was computer science or computer literacy training.

No one can deny that the computer, specifically the microcomputer, is having a tremendous impact on the school of today. It is well accepted that the microchip technology which gave us small inexpensive computers is one of the reasons for this increased interest. But what is meant by this term computer literacy and why should we as educators be concerned about the implementation of a computer literacy curriculum at the elementary, secondary, and higher education level? What problems are being raised by this curriculum development effort? This presentation will attempt to answer these questions. My intention is to provide

you with a rationale for teaching computer skills; to provide some common definitions of computer literacy; to give you some feeling for what is currently being done with computer literacy curriculum across all levels; and to help you focus on problems that are likely to occur because of this new curriculum development.

A Rationale for Teaching About and With Computers

At present our society is at a stage in between the industrial revolution which relied on the operation of machinery and a new revolution which will rely heavily on computers and other communications technology to distribute and move information (Culbertson, 1981). This new revolution--the information high technology revolution is developing at a rate at least three times as fast as the industrial revolution (Culbertson, 1981). Our ability to thrive economically as a nation will depend upon how well we train our population in the skills required to work in new brain intensive industries (Forbes & Gisi, 1982; Deringer, 1982). We must train our young and retain our old. For according to Department of Labor statistics, currently one half the work force and one half of the gross national product is involved in information industries. From all indications these trends will continue to increase.

The basic skills required by a worker of tomorrow are slightly different than the ones we stress today. The information skills needed for the future include: evaluation and analysis, critical thinking, problem solving, organizational and reference skills. The ability to synthesize and apply information, the ability to make decisions and communicate information will be important skills as well (Forbes & Gisi,

1982). There is no doubt that the computer with its ability to store, sort and manage information will be at the heart of the information industries. Therefore, along with the higher level basic skills I have just mentioned, the ability to use the computer to obtain and manipulate information or data will be a much needed skill (Deringer, 1982). Unfortunately, as stated in a recent article in the School Administrator, "The gap between the number of high-skilled workers needed and the number of students prepared for these higher-level jobs is widening. Clearly we are not cultivating the raw materials, our future workers, who will be vital for both economic progress and ultimately for economic survival" (Forbes & Gisi, 1982, p. 17).

The issue of training workers in high technological skills is not being ignored in other countries. France has established a World Computing Center in Paris with a twenty billion dollar budget to help itself and third world countries prepare their work force for computing and telecommunications industries (Deringer, 1982). In England educational activities in computer literacy training are being supported by the government through the establishment of a three year program to develop micro-electronic education curriculum within the school system. There is a twenty-four million dollar budget to promote changes within the curriculum, to develop materials and to train teachers. This money does not include the ten million dollars being spent on purchasing microcomputers for English schools (T.H.E., 1982). Japan has also made it a national goal to surpass other nations in the high technology market. The government is not only providing money for training in this area, but they are also providing financial aid to companies involved in computer development (Deringer, 1982).

How is the United States doing in its computer training efforts? At the present time there is no national policy toward technological training in public schools. In a recent NSF report on Science and Engineering for the 1980's it was stated that the current population is fast becoming technologically illiterate with only a minimal knowledge of science and mathematics (Molnar, 1980). The emphasis that is placed on these subjects by American schools is very limited. For example, in a 25 hour week the average elementary school student receives only one hour of science and less than four hours of math (Paul Hurd cited in Deringer, 1982). In high school only 9.1% of students take one year of physics, 16% take a year of chemistry, 45% take one year of biology and 17% take one year of general science (Molnar, 1980). It is no wonder that the country is suffering from a shortage of engineers and scientists (Molnar, 1982). There has been a steady decline in science and mathematics achievement scores among students for the past 15 years. This is due in part to a decrease in the number of qualified math and science teachers. Since the 1970's there has been a 77% decline in the number of math teachers and a 65% decline for those in science (Hurd cited in Deringer, 1982). Other countries are making national efforts to stress training in science, mathematics and technology. We cannot afford to ignore this type of training among our own population, particularly if we are to maintain our present lead in the high technology and information industries. Therefore, a commitment must be made on the local, state and national level to see that our young and old citizens have the skills necessary to work and live in an information society. Computer literacy training is one such skill.

Computer Literacy Defined

What is computer literacy? At present the only thing agreed upon by advocates of computer literacy is that there is no agreed upon meaning for the term. I will give you several definitions, you can choose the one that suits your particular curriculum taste.

Once I heard Arthur Luerhmann, former director of the Lawrence Hall of Science computer science program, define computer literacy as a small consulting company in California of which he is a member. However, Luerhmann does have definite opinions about the matter. He states that "The goal of defining computer literacy is of great importance. Much hangs on it. If the public decides the subject is worth teaching in its schools, then if faces an equipment bill of about one billion dollars in the U.S. alone. It faces additional costs of curriculum development, of teacher training, and the assessment of student achievement" (Luehrmann, 1981, p. 682). Luehrmann defines computer literacy as the ability to do computing. This translates into hands-on experience with the computer by learning to control and program it using a computer language. Luehrmann is slightly disdainful of those who try to say that computer literacy involves learning activities that can be done without the computer. Luehrmann states that the "...doers of computing have a knowledge qualitatively superior to that of the hearers about computing" (Luehrmann, 1981, p. 684).

Minnesota is one of the few states that has established a state consortium effort to define and develop a computer literacy curriculum. Contrary to Luehrmann's definition, the representatives of the Minnesota Educational Computing Consortium (MECC) define computer literacy as "the knowledge and skills the average citizen needs to know (or do) about

computers" (Anderson, Klassen, Johnson, 1981, p. 688). MECC has developed a comprehensive curriculum that involves not only programming experience, but that also emphasises how computers can be used in various fields and the consequences of their use. The computer literacy knowledge base, according to MECC representatives, encompasses the following domains: programming and algorithms, skills in computer usage, hardware and software principles, major uses and application principles, personal and social impacts, limitations of computers, and the development of relevant values and attitudes toward the computer (Anderson, Klassen, and Johnson, 1981). This definition emphasises both hands-on experience with and factual information about the computer.

Daniel Watt (1980), a research associate with MIT LOGO, states that the concept of computer literacy is based on the definition of literacy as the ability to read and write and the state of being well informed and educated. He states "a literate person can make use of a wider range of intellectual strategies than those available to someone who is non-literate." Therefore, computer literacy "...is a collection of skills, knowledge, understandings, value and relationships that allows a person to function comfortably as a productive citizen of a computer oriented society" (Watt, 1980, p. 26). The areas that are included in computer literacy according to Watt's definition are as follows:

1. The ability to control and program a computer for personal, academic and professional goals;
2. The ability to use a variety of computer software applications within a personal, academic and professional context;
3. The ability to understand growing economic, social and psychological impacts that computers are having on groups and individuals;

4. The ability to make use of ideas from the world of computer programming and computer applications as part of an indiyidual's strategy for retrieving information, communicating and problem solving.

Beverly Hunter of the Human Resources Research Organization (HumRRO) defines computer literacy as the skills "...a person needs to know and do with computers in order to function in our information based society" (Hunter, 1981, p. 1). Hunter thinks that the specific skills that a person will need will depend upon the individual and the type of job and the time period. For example, the knowledge and skills required by a computer programmer would be different than the kinds of knowledge and skills required by a teacher. The content areas which Hunter includes in the development of computer literacy are as follows:

1. Impact of computing on society, my work, my institution
2. Applications in various fields
3. Programming and problem solving
4. Hardware/software systems
5. Awareness of careers
6. Personal tool for learning and working
7. Control of machines, systems
8. Ethical and responsible behavior with information systems

As you can see there are some commonalities within these definitions. Hands-on experience with the computer is definitely emphasized as is the development of programming skills. A knowledge of hardware systems and the ability to use software packages are also a part of computer literacy training. In addition, computer literacy involves the

ability to use the computer to solve numerical, logical, and informational problems. Another important thread that runs through most of these definitions is the effort to discuss the social and psychological impact of computer use. Now that you roughly know what the term computer literacy means, let me provide you with some examples of different approaches to computer literacy which are being adopted by schools and universities across the country.

Approaches to Computer Literacy Curriculums

As part of a two year computer literacy project MECC surveyed the country to find out what was being taught in public schools with regard to computer skills (Hansen, Klassen, Anderson & Johnson, 1979). From their survey several patterns emerged. The courses were on either the junior high or secondary level. At the junior high level the courses were 2-4 weeks long and either focused on computer awareness (dealing with the impact, careers, and applications) or they combined computer awareness with hands-on programming. At the senior high level the courses ranged from 9-18 weeks in length and either focused on computer in mathematics where programming is taught as a mathematical problem solving tool or on BASIC language programming.

One such course is currently being taught at the T. J. Rusk Middle School in Nagodoches, Texas. The creator of the course, Bill Welch, wanted to provide an option to eighth grade students who have no need to review their basic math skills and who have no desire to take algebra at this time. With support from the Texas Education Agency in the form of Title IV, Part C funds, the school was able to purchase 20 microcomputers for a computer laboratory. The course covers the following units:

1. Introduction to computers
2. Introduction to the PET
3. Introduction to BASIC
4. Computer arithmetic and program management
5. Input, output, and simple applications
6. Decisions, branching and applications
7. Looping and functions
8. Working with collections of information
9. Do-it-yourself functions and subroutines
10. Random numbers and simulations
11. Flowcharting
12. Documentation

It was the intent of those responsible for the project that the course curriculum guide be exportable to any school district interested in implementing such a course. The units covered in the course are typical of those offered in other computer mathematics courses.

One problem with the single course concept is that often the course is only available to a few students. Either there are prerequisite skills that are required (i.e. Algebra I), or the course is offered as an elective. I was recently told by someone in the Austin Independent School District that although students will have a computer literacy course to be offered as an elective in the seventh grade, the students only have room for one elective. They must choose computer literacy to the exclusion of something else like band. Therefore, one problem confronting educators is how do we develop computer literacy skills in all students?

Another approach is to infuse computer literacy skills throughout the curriculum. This type of approach is being developed by the Human Resources Research Organization (HumRRO) and the Montgomery County Public Schools (Hunter, 1980). The philosophy behind the infusion approach is that once specific computer literacy goals have been determined, they can be integrated into the existing math, social studies and science curriculum in grades K-8. The Computer-Lit project as it is known, is being supported with NSF funds. The project plans to develop a curriculum guide that will include topics with instructional objectives targeted to the appropriate grade level and subject area. Suggested classroom activities and learning resources to support such activities will also be a part of the guide. The guides will have been developed with input from a national panel of experts, publishers, vendors, education specialists, and computer-experienced classroom teachers. The plan is to field test the curriculum in the Montgomery County Public Schools and then publish the field tested curriculum. The completion date for the project is September, 1983.

The advantage to using this infusion technique, as Hunter points out, is that it is developmentally sequenced and therefore, provides the students and teachers with some continuity. The sequence assures that all students receive training in computer literacy. It also means that students do not have to give something up in their studies to learn about computers. By providing an extensive curriculum guide, the project will have lessened the teacher's burden because the teacher will be able to find the kinds of information that will help them in building a lesson. The infusion approach, states Hunter (1980), is better than the separate computer literacy course approach because by infusing

computers throughout the curriculum one is providing students with a tool that can help them solve problems in math, science and social studies. "The whole point of computers in our information-based society", she says, "is to provide us with the tools we need to solve problems, to augment our intellects, and to give us relevant information when we need it" (Hunter, 2980, p. 7).

The Cupertino Union School District in California has also developed a K-8 computer literacy curriculum which was recently published in The Computing Teacher (Krause, 1981). This district has worked in stages over a period of three years to train teachers to the point where an extensive curriculum seemed feasible. Financial support was drawn from a variety of sources: title monies for the gifted and the handicapped, donations, existing school accounts and for the 1981-82 school year the board allocated capital expenditure funds. Each junior high will have 12 microcomputers with two disk drives and a printer. Each elementary school that agrees to participate will receive five microcomputers. The computers will be placed in the media center, but some will be on carts to be circulated to the classroom. In grades 3-6 the use of the computer will be a part of the regular classroom routine. In grades 7-8 a course in computer awareness and introductory programming will be offered. The district has designed their course objectives so that they can be met through a single course or infused into the existing social studies, language arts, science and math curriculum. Here are the major goals and objectives of the course as they relate to the content areas across levels.

Students in social studies will:

1. Become familiar with a computer
2. Be able to describe how it effects our lives
3. Be able to describe how computers are used by social scientists.

Students in language arts will:

4. Be able to define and spell basic computer terms
5. Be able to tell about a person or an event that influenced the historical development of computing devices
6. Be able to describe how computers are used in information and language related careers.

Students in science will:

7. Be able to define "computer" and "program"
8. Be able to explain how computers are used by scientists
9. Be able to use a computer to accomplish a simple task

Students in mathematics will:

10. Be able to explain that the design and operation of a computer is based on standard logic patterns
11. Be able to demonstrate how a computer could be used to accomplish a logical arithmetic task (Krause, 1982).

Interesting things are happening in computer literacy training on the college level. Some colleges such as Pepperdine, Hamline, and Rochester Institute of Technology, are requiring that students take a course in computers prior to graduation. At Dartmouth, where the BASIC language was developed and where 93% of the student body already uses computers, the university bookstore is selling and renting computers to students. Carnegie-Mellon University has decided that within the next 3 to 5 year period they will require each student to purchase a $3,000 personal computer, in addition to the traditional textbooks. According

to Dr. Richard Horn, the provost and senior vice president of CMU, there were four possible approaches that the university could have taken to encourage computer literacy competencies among students:

Electives: where students take computing on an optional basis.

Literacy: where computing is seen as a basic area of knowledge and skill that students should have;

Skill: where computing is viewed as a required basic skill like mathematics and language arts;

Foundation: where computing is seen as a key to information processing which is in turn seen as fundamental to the process of learning (cited in McCredie, 1981).

Another phenomenon that is occurring in teacher training institutions is the development of programs of study in educational computing on the graduate and undergraduate level. A few of these include Arizona State University, Columbia University Teacher's College, Stanford University and North Texas State. Lesley College has an undergraduate program which requires each education student to take an introductory course in computers and provides the option of having a teaching minor in computer science. The minor emphasises an understanding of computers and an opportunity to have laboratory experience with computers. Undergraduate students must take a total of 14 hours from the following course selection:

1. Programming in BASIC
2. Programming in LOGO
3. Computer Structure: Fundamentals of Organization and Operation
4. Information Systems for Computers
5. Programming in PASCAL

The graduate program is composed of nine different computer courses. These include:

1. Computer Literacy/Introduction to BASIC, PILOT, DYNAMO, and LOGO
2. Computers in the Schools: Applied uses for Teachers, Administrators and Specialists
3. Programming in BASIC: a Structured Approach
4. Programming in LOGO
5. Computers and the Special Needs Child
6. Introduction to Computer Simulation
7. Programming in PASCAL: Intermediate Programming Techniques
8. Fundamentals of Computer Structure
9. Evaluation and Development of Educational Software
10. Field Placement

These programs have only just begun. Lesley College is finding that building the programs requires the hiring of new faculty plus retraining of old faculty, but they are also finding the whole process to be very challenging. In the future most teacher training institutions will have to include computer literacy training for both inservice and preservice teachers. Particularly if the state teacher certification requirements change to make computer skills a teaching competency.

Problems with Computer Literacy

I have already discussed one of the problems relating to computer literacy, that is a need for a national commitment to developing computer skills. However, two other major issues emerge with computer

literacy implementation: that of teacher training and equity of access. I will address these now.

Arthur Luehrmann (1982) recently made a prediction about the impact that the computer literacy movement will have on the educational system. Within the next 3 years the average secondary student will have a computer laboratory with 16 microcomputers at his or her discretion, and 50,000 secondary school teachers will be teaching computing. As a result, the average college entrant will have at least one year of computing. Within five years each entrant will have at least two semesters of advanced programming and extensive word processing experience. Of course, these students will be expecting the same kinds of facilities at the college level. Will colleges be ready or will students be frustrated by overcrowded computer science courses and limited computer access? What is the current picture?

In a recent study of computer usage in higher education Gillespie (1981) found three major uses: instruction, research and administration. The major portion of the money and time allocated to the computer is being used for administrative purposes and it is increasing at a rate that exceeds the other two. The funds supporting instructional computing on the college level has dropped from 30% to 25% (McCredie, 1981). In addition, support staff and computer science faculty are at a shortage. Part of the problem is that colleges can not afford to compete with the salaries that are currently being offered by business and industry. This problem is likely to increase over time. Thus, if higher education is expected to help turn out computer literate workers and teachers for tomorrow's information society, then more money must be spent on increasing the instructional computing facilities, computer

support staff and on new faculty. This also means that a staff development effort must be made in terms of training existing faculty in computer literacy skills. This retraining effort will not be easy because college faculty have a natural aversion to technology (Meirhenry, 1977). Indeed, a faculty member's use of technology does not often receive support from the college system. Hunter (1981) points out that until faculty receive some reward for using technology, such as publishing credit for development computer assisted instruction in deciding tenure, faculty members will not voluntarily devote time to the task of learning to use technology.

Retraining of college of education faculty becomes mandatory when they are expected to certify both preservice and inservice teachers in relation to computer literacy skills. Currently, those in teacher education are not computer literate themselves. Another concern is that most teacher education programs still have a very traditional focus. Few teaching methods courses reflect work with computers, computer assisted instruction much less other technology. Arthur Luehrmann (1982) suggests that colleges of education should welcome the opportunity to teach the 50,000 to 100,000 teachers that will require computer literacy training over the next decade. He states "What better source of rejuvenation is there for colleges of education currently feeling demoralized by a drop in demand for teachers caused by a shrinking school age population...? (Luerhmann, 1982, p. 26).

Equity is the other major issue. What I mean by this is that all students should have equal access to computers so that each one has the opportunity to develop the skills they will need in the future. Most affluent schools are finding ways to purchase computers, but with

federal funds drying up the poorer school districts will not have the money to buy computers. And when poorer districts do manage to purchase computers, usually the students use them only for remedial drill and practice work. These students are not learning to control the computer like their affluent counterparts. As previously mentioned, computer literacy courses often have prerequisite math requirements, leaving the computer available to an elite few. And when the course is available on an elective basis, it must compete with others.

In addition, a special effort must be made to encourage females to participate equally in developing computer skills. Winkle and Mathews (1982) state that not only do girls have a culturally derived fear of technology, they also suffer from math anxiety (although they excel in math and science in elementary school). "The idea that computers are too complex to be understood by the average woman," Winkle and Mathews state, "...not only keep women out of computer and information science fields but also discourages them from taking advantage of opportunities for learning about computers." (Winkle & Mathews, p. 315). Thus, we must ensure that all children regardless of given intelligence, sex, socio-economic status and ethnic origin receive equal consideration in terms of learning to control the computer. For unless we do, those who work with their brains will become even more advantaged than those who must work with their muscle. And the gap between the haves and have nots will increase.

Conclusion

In conclusion, it seems to me that several things need to happen to make computer literacy a reality. First, there needs to be a commitment

made on the national, state and local level to develop within the young and old alike the kinds of skills needed to function in an information based society. This not only means strengthening our educational programs in math and science, but fostering an educational climate where people learn to control the computer and use it to solve problems. Second, computer literacy curriculum planning efforts must occur at all levels: elementary, secondary, college and in continuing and adult education programs. In developing that curriculum we must keep an eye on what kinds of knowledge and skills people are going to need to perform in whatever job they choose. We must also try to develop a of skills that are developmentally based. We must consider how this scope and sequence will impact in terms of staff and facilities. Third, we must attempt to deal with the issue of equity. If computer literacy is a basic skill needed by all U.S. citizens, then measures must be taken to give all equal opportunity to obtain that basic skill. Fourth, the curriculum efforts must be supported with personnel and facilities at all levels of schooling. This may mean that higher salaries are paid to keep qualified teachers within the educational system. We must be willing to spend our money on the appropriate computer hardware and software. Finally, we must begin to train preservice and inservice teachers not only in computer skills but in methods of using the computer for classroom instruction. This training effort will require a commitment from the teacher training institutions to provide the expertise in educational computing through the hiring of new faculty and the retraining of existing faculty.

I think it is clear why computer skills will be important in the future. We, as educators, must be willing to accept the challenge of

learning these new skills. Not only for the sake of our jobs, but for the sake of our children's economic future. Why should we make a commitment? To give students like Lewis Stewart a chance. Lewis, according to a recent issue of Time, is a fourteen year old black student who reads at a fifth grade level. Lewis is not only viewed as his school's best programmer, he also works for a computer consulting firm teaching other children. Lewis says "I love these machines. I've got all this power at my fingertips. Without computers I don't know where I will be. With them, I'm somebody." (Time, 1982, p. 52).

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